Murata LoRa modem command specification

Version: 0.8

Release Date: June 1, 2017

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Release History

Version Number	Release Date	Comments
0.1	2016-08-12	Initial version.
0.2	2016-10-12	Add pin assignment in chapter 2 Update message type in chapter 3.3.3 Add AT+MODE commands Remove device EUI configuration command Add ACK message for confirmed data transmission Add activation example Fix typo error
0.3	2016-12-07	Add commands about firmware upgrade over UART
0.4	2016-12-15	Remove transparent transmission mode. Add new event for payload length. Add comment for data transmission command. Fix typo error.
0.5	2016-12-26	Add GPIO definition for bootloader mode. Add new commands: AT+DBG,AT+BAND,AT+CLASS,AT+LNCHECK,AT+NWK, AT+ADR,AT+DR,AT+DELAY,AT+RX2, AT+DUTYCYCLE, AT+SLEEP,AT+PORT,AT+REP,AT+MCAST, AT+PUTX and AT+PCTX. Add RFO and PABOOST parameter in AT+RFPOWER Add port information in received message. Add NOACK
0.6	2017-03-14	Support more bands which are defined in LoRaWAN spec 1.0.2 in AT+BAND command Remove some conventions in chapter 3.1 Modify the default UART baud rate to 19200. Limit the UART baud rate within 4800, 9600, 19200, 38400 Modify the response format of AT+VER and AT+RFPARAM command Modify the parameter of AT+DBG command Modify the parameter of AT+RFPOWER to index value Add new commands AT+DFORMAT, AT+TO,AT+MSIZE and AT+RFQ Remove parameter timeout in AT+UTX, AT_CTX, AT+PUTX and AT+PCTX commands. Add appendix 5.3,5.4,5.5and 5.6
0.6a	2017-03-21	Remove class B in AT+CLASS command. Add comment in AT+DUTYCYCLE command. Add comment in RF power encoding
0.7	2017-03-28	Add device EUI configuration command
0.8	2017-06-01	Add more information about GPIO. Add new commands AT+DWELL, AT+MAXEIRP, AT+RSSITH, AT+CST and AT+BACKOFF.

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1. Introduction

Murata LoRa module is LoRaWAN compatible module, which supports flexible LoRaWAN communication. This document is intended to describe a command interface implementation of LoRaWAN Class A/C protocol.

This version is preliminary version. Some commands may be modified in the following version.

1.1 Assumptions

The reader is assumed to know LoRaWAN specification, which is released by LoRa Alliance.

1.2 Acronyms

LoRa	Long range radio technology
LoRaWAN	LoRa wide area network
ABP	Activation by personalization
OTAA	Over-the-Air activation
ADR	Adaptive data rate

2. Overview

2.1 System overview

The interface between Murata LoRa module and the host device is UART. Once UART is connected, host device can be easily to configure the LoRa module, transmit data to application server or receive data from application server.

2.2 Pin assignment

2.2.1 UART interface

There are two UART interface on Murata LoRa module

- Pin23/Pin24: AT command interface
- Pin18/Pin19: Debug interface

If the debug is enabled and debug level is configured, the debug information will be output from debug interface.

2.2.2 GPIO for factory new

Pin14 is configured as input for factory new function. And the pin is pull-up internally by default. In normal work mode, Pin14 should be pulled up. If this pin is pulled down continuously for more than 5 seconds and then pulled up, the module will be restored to factory new. The factory new configuration refers to Appendix 5.3.

This GPIO is not mandatory. User can also use AT command to restore the module to factory new. If the GPIO is not needed, the GPIO can be floating.

2.2.3 GPIO for bootloader

Pin33 is configured as input to enter bootloader mode. And the pin is pull-up internally by default. In normal boot-up, Pin33 should be pulled up. If this pin is pulled down continuously and power on the module, the module will enter bootloader mode. User can use AT commands to uploaded image file and upgrade firmware.

This GPIO is not mandatory. User can also use AT command to enter bootloader mode. If the modem firmware is broken, user can enter bootloader mode via GPIO operation. If the GPIO is not needed, the GPIO can be floating.

3. AT Command Reference

Murata LoRa module supports a variety of commands for configuration and operation. This section describes these commands and messages in detail and provides examples.

AT command and response include five types as below

Command Type	Description	Example
Configuration command	Set the parameter value	AT+DEVADDR=<>
Query command	Get current parameter value	AT+DEVADDR?
Executive command	Execute some command	AT+JOIN
Response	Response of command	+OK
Message	Message from application server	+STATUS=<>

3.1 Conventions

- Command is case insensitive;
- All commands have response;
- <> means the parts must be included. [] means the parts is optional;
- The default UART configuration for AT command interface is "19200, 8, n, 1" (8 bits data, no parity, 1 stop bit);
- The default UART configuration for debug interface is "115200, 8, n, 1" (8 bits data, no parity, 1 stop bit);

3.2 Symbols

AT instruction protocol is based on the instruction of ASCII command style, the description of syntax symbol as follow.

- AT+ -->Prefix of command
- + --> Prefix of response
- = --> Set value for command
- ? --> Query
- (Space) --> Empty character, Used to format command
- , --> Separator of parameters
- \r --> CR(Carriage Return), ASCII: 0x0D
- \n --> LF(Line Feed), ASCII: 0x0A

3.3 Format

3.3.1 Command syntax

AT+<CMD>[OP][PARA1,PARA2...]\r[DATA]

- AT+: Prefix of command message
- <CMD>: Command string
- OP:
  - = : For configuration command
  - ? : For query command
  - Space: For executive command
- [PARAx]: Parameter of command
- [DATA]: Transmission data payload when CMD is UTX, CTX, PUTX or PCTX.

3.3.2 Response Syntax

+<RSP>[OP][PARA1,PARA2...]\r\n\r\n

- +: Prefix of response message
- RSP: Response string
  - OK: Success
  - ERR: Failure
- OP:
  - "=" : Response message or error information
- [PARAx]: Parameter of response

3.3.3 Message Syntax

+<MSG>[OP][PARA1,PARA2...]\r\n\r\n[DATA]

- +: Prefix of incoming message
- MSG: Message or Event string
  - RECV: Data from Concentrator
  - EVENT: Module status
  - ACK/NOACK: ACK/NOACK from concentrator
- OP:
  - "=": Status or event information

- [PARAx]: Parameter of message
- [DATA]: Received data when MSG is RECV

4. AT Command Instruction

4.1 Basic command

4.1.1 AT

- Function description

This command is used to verify whether the interface between host and modem is operating correctly or not. The response +OK means that the connection is OK.

- Command format

Command type	Command format	Response format
Executive command	AT\r	+OK\r\n\r\n

- Example

Command:

AT\r

Response:

+OK\r\n\r\n

4.2 UART command

4.2.1 AT+UART

- Function description

This command is used to configure or query UART configuration for AT modem. User can only configure the baud rate of UART interface. Other UART parameters are hard coded. Once UART baud rate is modified, user needs to send AT+REBOOT command to validate new configuration.

- Command format

Command type	Command format	Response format
Query command	AT+UART?\r	+OK=<baudrate>,<data_bit>,<stop_bit>,<parity>,<flow_ctrl>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+UART =<baudrate>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment

baudrate	UART baud rate	Acceptable value: 4800, 9600, 19200,38400 Default value is 19200
data_bit	data bit	Default value is 8
stop_bit	stop bit	Default value is 1
parity	Parity	Default value is 0, which means none.
flow_ctrl	flow control	Default configuration is flow control disabled.

- Example

Command:

AT+UART?\r

Response:

+OK=19200,8,1,0,0\r\n\r\n

Command:

AT+UART =192000\r

Response:

+OK\r\n\r\n

4.3 System command

4.3.1 AT+VER

- Function description

This command is used to query the version information.

- Command format

Command type	Command format	Response format
Query command	AT+VER?\r	+OK=<fw_version>,<build_time>\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
fw_version	firmware version	x.x.xx
build_time	build time	MMM DD YYYY HH:MM:SS

- Example

Command:

AT+VER?\r

Response:

+OK=0.0.01,Oct 10 2016 11:10:57\r\n\r\n

4.3.2 AT+DBG

- Function description

This command is used to disable debug function or configure debug level. The default configuration is disabled.

- Command format

Command type	Command format	Response format
Query command	AT+DBG?\r	+OK=<level>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+DBG=<level>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
level	UART debug level	0: Disable 1: Enable only error information 2: Enable error and warning information 3: Enable error, warning, debug information 4: Enable all information

- Example

Command:

AT+DBG?\r

Response:

+OK=1\r\n\r\n

Command:

AT+DBG=0\r

Response:

+OK\r\n\r\n

4.3.3 AT+DEV

- Function description

This command is used to query the hardware information.

- Command format

Command type	Command format	Response format
Query command	AT+DEV?\r	+OK=<hw_name>\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
hw_name	hardware name	0: ABZ-093

- Example

Command:

AT+DEV?\r

Response:

+OK=ABZ-093\r\n\r\n

4.3.4 AT+REBOOT

- Function description

This command is used to reboot module. If LoRa modem reboots successfully, LoRa modem will send event to host MCU.

- Command format

Command type	Command format	Response format
Executive command	AT+REBOOT\r	+OK\r\n\r\n

- Example

Command:

AT+REBOOT?\r

Response:

+OK\r\n\r\n

4.3.5 AT+FACNEW

- Function description

This command is used to restore modem to factory new. If LoRa modem is restored to factory new successfully, LoRa modem will send event to host MCU and then reboot automatically.

- Command format

Command type	Command format	Response format
Executive command	AT+FACNEW\r	+OK\r\n\r\n

- Example

Command:

AT+ FACNEW?\r

Response:

+OK\r\n\r\n

4.4 MAC command

4.4.1 AT+BAND

- Function description

This command is used to configure or query radio band to be used. In case the radio band is changed, the modem will be automatically deactivated. And need to reboot to validate new configuration. The default band is EU868MHz.

- Command format

Command type	Command format	Response format
Query command	AT+BAND?\r	+OK=<band>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+BAND=<band>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
band	radio band	0: AS923 1: AU915 2: RFU 3: RFU 4: RFU 5: EU868 6: KR920 7: IN865

		8: US915 9: US915-HYBRID

- Example

```
Command:
  AT+BAND?\r
Response:
  +OK=5\r\n\r\n
Command:
  AT+BAND=0\r
Response:
  +OK\r\n\r\n
```

4.4.2 AT+CLASS

- Function description

This command is used to configure or query LoRa class mode. In case the class is changed in modem firmware, user should change the class information in gateway side accordingly. If the activation mode is OTAA, user should do the joining procedure again. The default configuration is class A.

- Command format

Command type	Command format	Response format
Query command	AT+CLASS?\r	+OK=<class>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+CLASS=<class>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
class	class mode	0: class A 2: class C

- Example

Command:

AT+CLASS?\r

Response:

+OK=0\r\n\r\n

Command:

AT+CLASS=0\r

Response:

+OK\r\n\r\n

4.4.3 AT+MODE

- Function description

This command is used to configure or query activation mode. The default activation mode is ABP.

- Command format

Command type	Command format	Response format
Query command	AT+MODE?\r	+OK=<mode>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+MODE=<mode>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
mode	activation mode	0: Personalization activation 1: Over-the-Air activation

- Example

Command:

AT+MODE?\r

Response:

+OK=1\r\n\r\n

Command:

AT+MODE=0\r

Response:

+OK\r\n\r\n

4.4.4 AT+DEVADDR

- Function description

This command is used to configure or query device address.

- Command format

Command type	Command format	Response format
Query command	AT+DEVADDR?\r	+OK=<addr>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+DEVADDR=<addr>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
addr	end device address,4 bytes hexadecimal number	010203AA

- Example

Command:

AT+DEVADDR?\r

Response:

+OK=010203AA\r\n\r\n

Command:

AT+DEVADDR=010203AA\r

Response:

+OK\r\n\r\n

4.4.5 AT+DEVEUI

- Function description

This command is used to query the globally unique device identifier. Device EUI is hard coded in production line.

- Command format

Command type	Command format	Response format
Query command	AT+DEVEUI?\r	+OK=<deveui>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+DEVEUI=<deveui >\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
deveui	the globally unique device identifier,8 bytes hexadecimal number	01020304AABBCCDD

- Example

Command:

AT+DEVEUI?\r

Response:

+OK=01020304AABBCCDD\r\n\r\n

Command:

AT+ DEVEUI =01020304AABBCCDD\r

Response:

+OK\r\n\r\n

4.4.6 AT+APPEUI

- Function description

This command is used to configure or query application identifier.

- Command format

Command type	Command format	Response format
Query command	AT+APPEUI?\r	+OK=<appeui>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+APPEUI=<appeui>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
appeui	application identifier,8 bytes hexadecimal number	01020304AABBCCDD

- Example

Command:

AT+APPEUI?\r

Response:

+OK=01020304AABBCCDD\r\n\r\n

Command:

AT+ APPEUI =01020304AABBCCDD\r

Response:

+OK\r\n\r\n

4.4.7 AT+NWKSKEY

- Function description

This command is used to configure or query network session key. This key is 16 bytes in length and provides security for communication between the module and the server.

- Command format

Command type	Command format	Response format
Query command	AT+NWKSKEY?\r	+OK=<nwkskey>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+NWKSKEY =<nwkskey >\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
nwkskey	network session key,16 bytes hexadecimal number	1029384756AFBECD5647382910DACFEB

- Example

Command:

AT+NWKSKEY?\r

Response:

+OK=1029384756AFBECD5647382910DACFEB\r\n\r\n

Command:

AT+NWKSKEY=1029384756AFBECD5647382910DACFEB\r

Response:

+OK\r\n\r\n

4.4.8 AT+APPSKEY

- Function description

This command is used to configure or query application session key. This key is 16 bytes in length and provides security for communication between module and application server.

- Command format

Command type	Command format	Response format
Query command	AT+APPSKEY?\r	+OK=<appskey>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+APPSKEY =<appskey>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
appskey	application session key,16 bytes hexadecimal number	1029384756AFBECD5647382910DACFEB

- Example

Command:

AT+APPSKEY?\r

Response:

+OK=1029384756AFBECD5647382910DACFEB\r\n\r\n

Command:

AT+APPSKEY =1029384756AFBECD5647382910DACFEB\r

Response:

+OK\r\n\r\n

4.4.9 AT+APPKEY

- Function description

This command is used to configure or query application key. This key is 16 bytes in length and is used to derive the security credentials for communication during over-the-air activation.

- Command format

Command type	Command format	Response format
Query command	AT+APPKEY?\r	+OK=<appkey>\r\n\r\n or +ERR=<err_no>\r\n\r\n

Configuration command	AT+APPKEY =<appkey>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
appkey	application key,16 bytes hexadecimal number	1029384756AFBECD5647382910 DACFEB

- Example

Command:

AT+APPKEY?\r

Response:

+OK=1029384756AFBECD5647382910DACFEB\r\n\r\n

Command:

AT+APPKEY =1029384756AFBECD5647382910DACFEB\r

Response:

+OK\r\n\r\n

4.4.10 AT+JOIN

- Function description

This command is used to join network in Over-the-Air activation mode.

- Command format

Command type	Command format	Response format
Executive command	AT+JOIN\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Example

Command:

AT+JOIN\r

Response:

+OK\r\n\r\n

+EVENT=1,1\r\n\r\n

4.4.11 AT+LNCHECK

- Function description

This command is used to check the LoRaWAN network connection status.

- Command format

Command type	Command format	Response format
Executive command	AT+LNCHECK\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Example

Command:

AT+LNCHECK\r

Response:

+OK\r\n\r\n

+EVENT=2,0\r\n\r\n

4.4.12 AT+RFPARAM

- Function description

This command is used to configure or query RF parameter of radio transceiver.

- Command format

Command type	Command format	Response format
Query command	AT+RFPARAM?\r	+OK=<num>;<lc_no>,<freq>,<dr_min>,<dr-max>;……\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+RFPARAM =<lc_no><freq><dr_min><dr-max>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
num	amount of logical channel	
lc_no	number of logical channel	
freq	frequency of radio transceiver, decimal number	868000000 Hz
dr_min	minimum data rate	0
dr_max	maximum data rate	5

- Example

Command:

AT+RFPARAM?\r

Response:

+OK=2\r\n0,86810000,0,5\r\n1,868300000,0,5\r\n\r\n

Command:

AT+RFPARAM =3,86850000,0,5\r

Response:

+OK\r\n\r\n

4.4.13 AT+RFPOWER

- Function description

This command is used to configure or query the output power of radio transceiver. The default RF mode is RFO and the power index is 1 for EU868.

- Command format

Command type	Command format	Response format
Query command	AT+RFPOWER?\r	+OK=<mode>,<index>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+RFPOWER =<mode>,< index>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
mode	RFO mode or PABOOST mode	0: RFO mode 1: PABOOST mode
index	output power of radio transceiver, signed decimal number	From 0 to 15. Refer to Appendix 5.5

- Example

Command:

AT+RFPOWER?\r

Response:

+OK=0,1\r\n\r\n

Command:

AT+RFPOWER =0,1\r

Response:

+OK\r\n\r\n

4.4.14 AT+NWK

- Function description

This command is used to query or configure whether to enable public network or not. The default configuration is public network.

- Command format

Command type	Command format	Response format
Query command	AT+NWK?\r	+OK=<network >\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+NWK=<network>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
network	network type	0: private network 1: public network

- Example

Command:

AT+NWK?\r

Response:

+OK=0\r\n\r\n

Command:

AT+NWK=1\r

Response:

+OK\r\n\r\n

4.4.15 AT+ADR

- Function description

This command is used to query or configure whether the adaptive data rate is enabled or not. The default value of ADR is enabled.

- Command format

Command type	Command format	Response format
Query command	AT+ADR?\r	+OK=<adr>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+ADR=<adr>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
adr	enable adaptive data rate or not	0: disable 1: enable

- Example

Command:

AT+ADR?\r

Response:

+OK=0\r\n\r\n

Command:

AT+ADR=1\r

Response:

+OK\r\n\r\n

4.4.16 AT+DR

- Function description

This command is used to query or configure data rate used for LoRaWAN transmission.

- Command format

Command type	Command format	Response format
Query command	AT+DR?\r	+OK=<dr>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+DR=<dr>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
dr	data rate.	From 0 to 15. Refer to Appendix 5.4

- Example

Command:

AT+DR?\r

Response:

+OK=0\r\n\r\n

Command:

AT+DR=1\r

Response:

+OK\r\n\r\n

4.4.17 AT+DELAY

- Function description

This command is used to query or configure the receive delay 1, receive delay 2, join accept delay 1 or join accept delay 2.

- Command format

Command type	Command format	Response format
Query command	AT+DELAY?\r	+OK=<join_acc_delay_1>,<join_acc_delay_2>,<rx_win_delay_1>,<rx_win_delay_2>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+DELAY=<join_acc_delay_1>,<join_acc_delay_2>,<rx_win_delay_1>,<rx_win_delay_2>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
join_acc_delay_1	join accept delay 1, time in milliseconds	
join_acc_delay_2	join accept delay 1, time in milliseconds	
rx_win_delay_1	receive window delay 1, time in milliseconds	
rx_win_delay_2	receive window delay 2, time in milliseconds	

- Example

Command:

AT+DELAY?\r

Response:

+OK=5000,6000,1000,1000\r\n\r\n

Command:

AT+DELAY=5000,6000,1000,2000\r

Response:

+OK\r\n\r\n

4.4.18 AT+RX2

- Function description

This command is used to query or configure the frequency and data rate parameters of the RX2 receive window.

- Command format

Command type	Command format	Response format
Query command	AT+RX2?\r	+OK=<freq>,<dr>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+RX2= <freq>,<dr>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
freq	frequency of RX2 receive window	
dr	data rate of RX2 receive window	

- Example

Command:

AT+RX2?\r

Response:

+OK=869525000,3\r\n\r\n

Command:

AT+RX2=869525000,0 \r

Response:

+OK\r\n\r\n

4.4.19 AT+DUTYCYCLE

- Function description

This command is used to query or configure duty cycle for EU868 and IN865bands. The duty cycle is mandatory to be set to on when using in Europe to follow ETSI regulation. Refer to Appendix 5.6 for detail information.

- Command format

Command type	Command format	Response format
Query command	AT+DUTYCYCLE?\r	+OK=<dc>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+ DUTYCYCLE =<dc>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
dc	duty cycle	0: disable 1: enable

- Example

Command:

AT+DUTYCYCLE?\r

Response:

+OK=1\r\n\r\n

Command:

AT+DUTYCYCLE=0\r

Response:

+OK\r\n\r\n

4.4.20 AT+SLEEP

- Function description

This command is used to query or configure low power mode of modem. Any signal on UART RX pin will make modem exit sleep mode. The default power mode is normal mode. If user wants to wake up modem from sleep node, user needs to send 'wakeup' to modem. And modem will send an event to host MCU. Then user can send other AT command to modem.

- Command format

Command type	Command format	Response format
Query command	AT+SLEEP?\r	+OK=<sleep>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+SLEEP=<sleep>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
sleep	sleep mode	0: normal mode 1: sleep mode

- Example

Command:

AT+SLEEP?\r

Response:

+OK=1\r\n\r\n

Command:

AT+SLEEP=0\r

Response:

+OK\r\n\r\n

4.4.21 AT+PORT

- Function description

This command is used to query or configure port number used for LoRaWAN transmission.

- Command format

Command type	Command format	Response format
Query command	AT+PORT?\r	+OK=<class>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+PORT=<port>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
port	port number	1~223

- Example

Command:

AT+PORT?\r

Response:

+OK=1\r\n\r\n

Command:

AT+PORT=2\r

Response:

+OK\r\n\r\n

4.4.22 AT+REP

- Function description

This command is used to query or configure unconfirmed message repeats times.

- Command format

Command type	Command format	Response format
Query command	AT+REP?\r	+OK=<rep>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+REP=<rep>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
rep	repeats times	1~15

- Example

Command:

AT+REP?\r

Response:

+OK=1\r\n\r\n

Command:

AT+REP=2\r

Response:

+OK\r\n\r\n

4.4.23 AT+DFORMAT

- Function description

This command is used to query or configure data format of sending and receiving message. The default configuration is text.

- Command format

Command type	Command format	Response format
Query command	AT+ DFORMAT?\r	+OK=<df>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+ DFORMAT =<df>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
df	data format	0: text 1: hex

- Example

Command:

AT+ DFORMAT?\r

Response:

+OK=0\r\n\r\n

Command:

AT+ DFORMAT=1\r

Response:

+OK\r\n\r\n

4.4.24 AT+TO

- Function description

This command is used to query or configure timeout configuration of payload UART transmission in AT+UTX, AT+CTX, AT+PUTX or AT+PCTX command. The timeout value depends on the length of payload and the band rate of UART interface. The value should be larger than (maximum_length_of _paylod*10)/(UART_baud_rate) .The default value is 1000 millisecond.

- Command format

Command type	Command format	Response format
Query command	AT+TO?\r	+OK=<to>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+TO=<to>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
to	timeout value of payload UART transmission	1~65535 millisecond

- Example

Command:

AT+TO?\r

Response:

+OK=1000\r\n\r\n

Command:

AT+TO=1000\r

Response:

+OK\r\n\r\n

4.4.25 AT+UTX

- Function description

This command is used to send string frame which doesn't need to be confirmed by server. The maximum length of payload depends on current data rate of LoRa modem. If the length exceeds maximum value, LoRa modem will return error message.

- Command format

Command type	Command format	Response format
Executive command	AT+UTX <length>\r<payload>	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
length	length of payload	1-256 bytes
payload	data entity	

- Example

Command:

AT+UTX 10\r1234567890

Response:

+OK\r\n\r\n

4.4.26 AT+CTX

- Function description

This command is used to send string frame which needs to be confirmed by server. The maximum length of payload depends on current data rate of LoRa modem. If the length exceeds maximum value, LoRa modem will return error message. When LoRa modem receives acknowledge from server, LoRa modem will send ACK to host MCU.

- Command format

Command type	Command format	Response format
Executive command	AT+CTX <length>\r<payload>	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
length	length of payload	1-256 bytes
payload	data entity	

- Example

Command:

AT+CTX 10\r1234567890

Response:

+OK\r\n\r\n

+ACK\r\n\r\n

4.4.27 AT+MCAST

- Function description

This command is used to query or add multicast addresses. The maximum number of multicast address is 8.

- Command format

Command type	Command format	Response format
Query command	AT+MCAST?\r	+OK=<num>; <id>,<addr>,<nwkskey>, <appskey>;…\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+MCAST=<id>,<addr>,<nwkskey>,<appskey>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
id	index	0~7
addr	device address	4 bytes
nwkskey	network session key	16 bytes
appskey	application session key	16 bytes

- Example

Command:

AT+MCAST?\r

Response:

+OK=1;0,00112233,00112233445566778899001122334455,
00112233445566778899001122334455\r\n\r\n

Command:

AT+MCAST=1,00223344, 00112233445566778899001122334455,
00112233445566778899001122334455\r

Response:

+OK=\r\n\r\n

4.4.28 AT+PUTX

- Function description

This command is used to send string frame with port which doesn't need to be confirmed by server. The maximum length of payload depends on current data rate of LoRa modem. If the length exceeds maximum value, LoRa modem will return error message.

- Command format

Command type	Command format	Response format
Executive command	AT+PUTX <port>,<length>\r<payload>	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
port	port number	1-256
length	length of payload	1-256 bytes
payload	data entity	

- Example

Command:

AT+PUTX 8,10\r1234567890

Response:

+OK\r\n\r\n

4.4.29 AT+PCTX

- Function description

This command is used to send string frame with port which needs to be confirmed by server. The maximum length of payload depends on current data rate of LoRa modem. If the length exceeds maximum value, LoRa modem will return error message. When LoRa modem receives acknowledge from server, LoRa modem will send ACK to host MCU.

- Command format

Command type	Command format	Response format
Executive command	AT+PCTX <port>,<length>\r<payload>	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
length	length of payload	1-256 bytes
payload	data entity	

- Example

Command:

AT+PCTX 8,10\r1234567890

Response:

+OK\r\n\r\n

+ACK\r\n\r\n

4.4.30 AT+MSIZE

- Function description

This command is used to query maximum length of payload under current data rate.

- Command format

Command type	Command format	Response format
Query command	AT+MSIZE?\r	+OK=<size>\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
rep	repeats times	1~256

- Example

Command:

AT+MSIZE?\r

Response:

+OK=51\r\n\r\n

4.4.31 AT+RFQ

- Function description

This command is used to query RF signal performance parameter of last received message.

- Command format

Command type	Command format	Response format
Query command	AT+RFQ?\r	+OK=<rssi>,<snr>r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
rssi	RSSI value of last received message	
snr	SNR value of last received message	

- Example

Command:

AT+RFQ?\r

Response:

+OK=-90,6\r\n\r\n

4.4.32 AT+DWELL

- Function description

This command is used to query or configure the uplink and downlink dwell time settings. This command is only used by band AS923MHz.

- Command format

Command type	Command format	Response format
Query command	AT+DWELL?\r	+OK=<uplink_dwell>,<downlink_dwell>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+DWELL=<uplink_dwell>,<downlink_dwell>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
uplink_dwell	uplink messages respect dwell time or not	0: disable 1: enable
downlink_dwell	downlink messages respect dwell time or not	0: disable 1: enable

- Example

Command:

AT+DWELL?\r

Response:

+OK=0,0\r\n\r\n

Command:

AT+DWELL=1,1\r

Response:

+OK\r\n\r\n

4.4.33 AT+MAXEIRP

- Function description

This command is used to query or configure the maximum EIRP(equivalent isotropic radiated power). This command is only used by band AS923MHz.

- Command format

Command type	Command format	Response format
Query command	AT+MAXEIRP?\r	+OK=<eirp>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+MAXEIRP=<eirp>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
eirp	maximum EIRP value	14dBm by default.

- Example

Command:

AT+MAXEIRP?\r

Response:

+OK=14\r\n\r\n

Command:

AT+MAXEIRP=20\r

Response:

+OK\r\n\r\n

4.4.34 AT+RSSITH

- Function description

This command is used to query or configure the threshold RSSI value used by LBT. This command is only used by band AS923MHz and band KR920MHz.

- Command format

Command type	Command format	Response format
Query command	AT+RSSITH?\r	+OK=<rssi>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+RSSITH=<rssi>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
rssi	threshold RSSI value	-85dBm by default.

- Example

Command:

AT+RSSITH?\r

Response:

+OK=-85\r\n\r\n

Command:

AT+RSSITH=-60\r

Response:

+OK\r\n\r\n

4.4.35 AT+CST

- Function description

This command is used to query or configure the CST (carrier sensor time) used by LBT. This command is only used by band AS923MHz and band KR920MHz.

- Command format

Command type	Command format	Response format
Query command	AT+CST?\r	+OK=<cst>\r\n\r\n or +ERR=<err_no>\r\n\r\n
Configuration command	AT+CST=<cst>\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
cst	carrier sense time in milliseconds	6 milliseconds by default.

- Example

Command:

AT+CST?\r

Response:

+OK=6\r\n\r\n

Command:

AT+CST=20\r

Response:

+OK\r\n\r\n

4.4.36 AT+BACKOFF

- Function description

This command is used to query the back-off time when duty cycle is enabled. During the back-off time, the device can not send any message.

- Command format

Command type	Command format	Response format
Query command	AT+BACKOFF?\r	+OK=<back_off>\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
back_off	back-off time	In milliseconds.

- Example

Command:

AT+BACKOFF?\r

Response:

+OK=63802\r\n\r\n

4.5 Message

4.5.1 +RECV

- Function description

This message is used to send received data from application server to host device.

- Message format

Message format
+RECV=<port>,<length>\r\n\r\n <data>

- Parameter description

Parameter	Description	Comment
port	port number	
length	length of received data	
data	received data	

4.5.2 +EVENT

- Function description

This message is used to indicate the event to host device.

- Message format

Message format
+EVENT=<type>,<event_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
type	event type	0: module status 1: network status
event_no	event code	Refer to Appendix 5.2

4.5.3 +ACK

- Function description

This message is used to indicate the ACK message from concentrator.

- Message format

Message format
+ACK\r\n\r\n

4.5.4 +NOACK

- Function description

This message is used to indicate that modem doesn't receive ACK message from concentrator.

- Message format

Message format
+NOACK\r\n\r\n

4.6 Firmware upgrade

4.6.1 AT+FWUPDATE

- Function description

This command is used to reboot device and enter bootloader to start firmware upgrade procedure.

- Command format

Command type	Command format	Response format
Executive command	AT+FWUPDATE\r	+OK\r\n\r\n

4.6.2 AT+FWBLOCK

- Function description

This command is used to transmit firmware block from host MCU to LoRa modem. The default block size is 128 bytes. Host MCU must transmit firmware block after receiving event from LoRa modem.

- Command format

Command type	Command format	Response format
Executive command	AT+FWBLOCK <index>\r<payload>	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Parameter description

Parameter	Description	Comment
index	index of the firmware block	Range: 0 ~ <firmware_size>/128 - 1
payload	firmware block entity, the length must equal to 128 bytes	00112233…XX

- Example

Command:

AT+FWBLOCK 0\r00112233445566778899001122334455667788990011223344556677889900112233445566778899001122334455667788990011223344556677889900112233445566778899001122334455667788990011223344556677889900112233445566778899001122334455667788990011223344556677889900112233445566778899001122334455667788990011223344556677

Response:

+OK\r\n\r\n

4.6.3 AT+FWDONE

- Function description

This command is used to indicate the completion of firmware transmission and upgrade to the new firmware

- Command format

Command type	Command format	Response format
Executive command	AT+FWDONE\r	+OK\r\n\r\n or +ERR=<err_no>\r\n\r\n

- Example

Command:

AT+FWDONE\r

Response:

+OK\r\n\r\n

4.6.4 AT+FWCANCEL

- Function description

This command is used to stop the procedure of firmware transmission and retain the original firmware.

- Command format

Command type	Command format	Response format
Executive command	AT+FWCANCEL\r	+OK\r\n\r\n

- Example

Command:

AT+FWCANCEL\r

Response:

+OK\r\n\r\n

5. Appendix

5.1 Error code description

Vlaue	Description
-1	Command is unknown
-2	The number of parameter is invalid.
-3	The content of parameter is invalid.
-4	Failed to restore to factory new state.
-5	Device is not in LoRaWAN network yet.
-6	Device is already in LoRaWAN network.
-7	LoRa MAC is busy in transmission.
-8	The version of the firmware to be updated is the same with the current one.
-9	Firmware information is not set.
-10	Error occurred when write/read flash memory.
-11	Failed to update firmware.
-12	The length of payload exceeds maximum value.
-13	Command only supported on ABP mode.
-14	Command only supported on OTAA mode.
-15	The band configuration is not supported by the device.
-16	Power value exceeds the range allowed by the power mode.
-17	Command is unusable under current band configuration.
-18	TX is not allowed due to duty cycle limits.
-19	No channel is available for TX due to LBT limits or error parameters.

5.2 Event code description

Type	Value	Description
0	0	Module reboots successfully.
	1	Module restores to factory new successfully.
	2	Module enters bootloader mode.

	3	Module wakes up from sleep mode.
1	0	Join request is rejected.
	1	Join request is accepted.
2	0	The link between modem and gateway is lost.
	1	The link between modem and gateway is connected.

5.3 Factory new configuration

Item	Value
Band	EU868
Channel	FREQ: 868100000, DR: 0~5 FREQ: 868300000, DR: 0~5 FREQ: 868500000, DR: 0~5
TX power	14dBm on RFO mode
ADR	Enable
Duty cycle	Enable
RX2 window frequency	869525000
RX2 window data rate	DR0 (SF12/125kHz)
Application key	2B7E151628AED2A6ABF7158809CF4F3C
Network session key	2B7E151628AED2A6ABF7158809CF4F3C
Application session key	2B7E151628AED2A6ABF7158809CF4F3C
Application EUI	0101010101010101
Join accept delay 1	5000ms
Join accept delay 2	6000ms
RX1 window delay	1000ms
RX2 window delay	2000ms
Port	2
Unconfirmed message retry	1
Activation mode	ABP
Network type	Public network
UART baud rate	19200
Sleep mode	Enable

Payload data format	Text
Data sending timeout	1000ms

5.4 Data rate scheme

5.4.1 AS923

Data Rate	Configuration	Indicative physical bit rate [bit/s]
0	LoRa: SF12/125kHz	250
1	LoRa: SF11/125kHz	440
2	LoRa: SF10/125kHz	980
3	LoRa: SF9/125kHz	1760
4	LoRa: SF8/125kHz	3125
5	LoRa: SF7/125kHz	5470
6	LoRa: SF7/250kHz	11000
7	FSK:50kbps	50000
8-15	RFU	

5.4.2 AU915

Data Rate	Configuration	Indicative physical bit rate [bit/s]
0	LoRa: SF10/125kHz	980
1	LoRa: SF9/125kHz	1760
2	LoRa: SF8/125kHz	3125
3	LoRa: SF7/125kHz	5470
4	LoRa: SF8/500kHz	12500
5-7	RFU	
8	LoRa: SF12/500kHz	980
9	LoRa: SF11/500kHz	1760
10	LoRa: SF10/500kHz	3900
11	LoRa: SF9/500kHz	7000
12	LoRa: SF8/500kHz	12500
13	LoRa: SF7/500kHz	21900

14-15	RFU	

5.4.3 EU868

Data Rate	Configuration	Indicative physical bit rate [bit/s]
0	LoRa: SF12/125kHz	250
1	LoRa: SF11/125kHz	440
2	LoRa: SF10/125kHz	980
3	LoRa: SF9/125kHz	1760
4	LoRa: SF8/125kHz	3125
5	LoRa: SF7/125kHz	5470
6	LoRa: SF7/250kHz	11000
7	FSK:50kbps	50000
8-15	RFU	

5.4.4 KR920

Data Rate	Configuration	Indicative physical bit rate [bit/s]
0	LoRa: SF12/125kHz	250
1	LoRa: SF11/125kHz	440
2	LoRa: SF10/125kHz	980
3	LoRa: SF9/125kHz	1760
4	LoRa: SF8/125kHz	3125
5	LoRa: SF7/125kHz	5470
6-15	RFU	

5.4.5 IN865

Data Rate	Configuration	Indicative physical bit rate [bit/s]
0	LoRa: SF12/125kHz	250
1	LoRa: SF11/125kHz	440
2	LoRa: SF10/125kHz	980
3	LoRa: SF9/125kHz	1760
4	LoRa: SF8/125kHz	3125

5	LoRa: SF7/125kHz	5470
6	LoRa: SF7/250kHz	11000
7	FSK:50kbps	50000
8-15	RFU	

5.4.6 US915

Data Rate	Configuration	Indicative physical bit rate [bit/s]
0	LoRa: SF10/125kHz	980
1	LoRa: SF9/125kHz	1760
2	LoRa: SF8/125kHz	3125
3	LoRa: SF7/125kHz	5470
4	LoRa: SF8/500kHz	12500
5-7	RFU	
8	LoRa: SF12/500kHz	980
9	LoRa: SF11/500kHz	1760
10	LoRa: SF10/500kHz	3900
11	LoRa: SF9/500kHz	7000
12	LoRa: SF8/500kHz	12500
13	LoRa: SF7/500kHz	21900
14-15	RFU	

5.4.7 US915-hybrid

Data Rate	Configuration	Indicative physical bit rate [bit/s]
0	LoRa: SF10/125kHz	980
1	LoRa: SF9/125kHz	1760
2	LoRa: SF8/125kHz	3125
3	LoRa: SF7/125kHz	5470
4	LoRa: SF8/500kHz	12500
5-7	RFU	
8	LoRa: SF12/500kHz	980
9	LoRa: SF11/500kHz	1760

10	LoRa: SF10/500kHz	3900
11	LoRa: SF9/500kHz	7000
12	LoRa: SF8/500kHz	12500
13	LoRa: SF7/500kHz	21900
14-15	RFU	

5.5 RF power encoding

5.5.1 AS923

TX Power	RF output power [dBm]	Comment
0	Max EIRP	
1	Max EIRP-2	
2	Max EIRP-4	
3	Max EIRP-6	
4	Max EIRP-8	
5	Max EIRP-10	
6-15	RFU	

5.5.2 AU915

TX Power	RF output power [dBm]	Comment
0	30	Not support
1	28	Not support
2	26	Not support
3	24	Not support
4	22	Not support
5	20	PA_BOOST mode
6	18	PA_BOOST mode
7	16	PA_BOOST mode
8	14	PA_BOOST or RFO mode
9	12	PA_BOOST or RFO mode
10	10	PA_BOOST or RFO mode
11-15	RFU	

5.5.3 EU868

TX Power	RF output power [dBm]	Comment
0	20	PA_BOOST mode
1	14	PA_BOOST or RFO mode
2	11	PA_BOOST or RFO mode
3	8	PA_BOOST or RFO mode
4	5	PA_BOOST or RFO mode
5	2	PA_BOOST or RFO mode
6-15	RFU	

5.5.4 KR920

TX Power	RF output power [dBm]	Comment
0	20	PA_BOOST mode
1	14	PA_BOOST or RFO mode
2	10	PA_BOOST or RFO mode
3	8	PA_BOOST or RFO mode
4	5	PA_BOOST or RFO mode
5	2	PA_BOOST or RFO mode
6	0	RFO mode
7-15	RFU	

5.5.5 IN865

TX Power	RF output power [dBm]	Comment
0	20	PA_BOOST mode
1	18	PA_BOOST mode
2	16	PA_BOOST mode
3	14	PA_BOOST or RFO mode
4	12	PA_BOOST or RFO mode
5	10	PA_BOOST or RFO mode
6	8	PA_BOOST or RFO mode
7	6	PA_BOOST or RFO mode
8	4	PA_BOOST or RFO mode
9	2	PA_BOOST or RFO mode

10	0	RFO mode
11~15	RFU	

5.5.6 US915

TX Power	RF output power [dBm]	Comment
0	30	Not support
1	28	Not support
2	26	Not support
3	24	Not support
4	22	Not support
5	20	PA_BOOST mode
6	18	PA_BOOST mode
7	16	PA_BOOST mode
8	14	PA_BOOST or RFO mode
9	12	PA_BOOST or RFO mode
10	10	PA_BOOST or RFO mode
11-15	RFU	

5.5.7 US915-hybrid

TX Power	RF output power [dBm]	Comment
0	30	Not support
1	28	Not support
2	26	Not support
3	24	Not support
4	22	Not support
5	20	PA_BOOST mode
6	18	PA_BOOST mode
7	16	PA_BOOST mode
8	14	PA_BOOST or RFO mode
9	12	PA_BOOST or RFO mode
10	10	PA_BOOST or RFO mode
11-15	RFU	

5.6 Band specific limitation

5.6.1 EU868 duty cycle limitation

Band index	Frequency (Hz)	Duty cycle
0	865000000~868000000	1%
1	868000000~868600000	1%
2	868700000~869200000	0.1%
3	869400000~869650000	10%
4	869700000~870000000	1%

5.7 Activation example

5.7.1 OTAA activation and confirmed data transmission

- AT+DEVEUI? \r (Note: Add device EUI in application server.)
- AT+APPKEY=1029384756AFBECD5647382910DACFEB\r (Note: Add same application key in application server.)
- AT+JOIN\r
- AT+CTX 10\r1234567890 (Note: Send confirmed data 1234567890 to application server. Modem can receive ACK message.)

5.7.2 ABP activation and confirmed data transmission

- AT+DEVEUI? \r (Note: Add device EUI in application server)
- AT+DEVADDR= 010203AA\r (Note: Add same device address in application server.)
- AT+APPSKEY=1029384756AFBECD5647382910DACFEB\r (Note: Add same application session key in application server.)
- AT+NWKSKEY=9087654321AFBECD5647382910DACFEB\r (Note: Add same network session key in application server.)
- AT+CTX 10\r1234567890 (Note: Send confirmed data 1234567890 to application server. Modem can receive ACK message.)

END